Supplementary Materials

Contents

A. Detailed Description of the PD for the Elementary School Science Topic of Floating and Sinking

Setting	Time (approx.)	Content	Methods and Didactics
Face-to-face meeting after school hours (PD duration including short breaks: 5 hours)	30 min	Welcome reception, overview over the PD training, clarification of teachers' expectations	Trainer input, brainstorming
	15 min	• Significance and function of natural sciences and experimentation in elementary school science • Typical steps in the scientific process (e.g., hypothesizing, planning and conducting experiments)	Trainer input
	15 min	Students' preconcepts: Reflection on and discussion of typical student explanations of why a ship floats on the water (e.g., because of its shape)	Work in pairs, reflection of teachers' own experiences, plenum discussion • Activation of teachers' PCK
	60 min	Concepts of material kind and density 1. Reflection on possible student assumptions regarding the floating and sinking of objects from different materials and density 2. Experimentation (e.g., putting objects of the same size but of different materials into a water basin and observing whether they float or sink) and discussion of the results 3. Explanation of the concept of density (i.e., by introducing the concepts of weight and volume) and illustration of possible visualizations (e.g., comparing the sizes of 100g-pieces of metal, wood, wax, and polystyrene) 4. Presentation of the respective lesson plans for the implementation in class	Hands-on experiments in small groups, trainer input, plenum discussion • Linking of input on CK and PCK with the contents and materials needed for teaching third grade science classrooms • Combination of input, practice, and reflection • Collaboration among participants
	90 min	Concepts of water displacement, water pressure and buoyancy force	Hands-on experiments in small groups, trainer input, plenum discussion

		1. Reflection on possible student assumptions for explaining water displacement and buoyancy force 2. Experimentation (e.g, putting pots of different sizes into a water basin and observing how much water gets displaced) and discussion of the results 3. Explanation of water displacement and buoyancy force (by drawing on the concepts of water pressure and volume) and illustration of respective visualizations 4. Presentation of the respective lesson plans for the implementation in class	• Linking of input on CK and PCK with the contents and materials needed for teaching third grade science classrooms • Combination of input, practice, and reflection • Collaboration among participants
	30 min	Question and answer-session regarding the PD contents	Plenum discussion • Clarification and consolidation of the PD contents

Note. The PD for the elementary school science topic of "floating and sinking" was based on a field-tested procedure (cf. Decker et al., 2020; Pollmeier et al., 2017).

B. Detailed Description of the PD for the Elementary School Science Topic of Evaporation and Condensation

Setting	Time (approx.)	Content	Methods and Didactics
Face-to-face meeting during school hours (PD duration including short breaks: 5 hours)	30 min	Welcome reception, overview of the PD, introduction (clarifying the significance of the topic of "evaporation and condensation"; e.g., regarding its importance for explaining everyday phenomena such as ice, fog, and rain)	Trainer input
	15 min	Elementary school students' preconcepts regarding the different aggregation states of water (e.g., water is absorbed by a surface when it actually evaporates) and possible challenges for teaching and understanding aggregation states and transition processes (e.g., invisibility of processes)	Trainer input, reflection of teachers' own experiences, plenum discussion
	90 min	Aggregation states of water and transition processes 1. Experimentation related to melting, condensation, and evaporation (e.g., comparing an ice cube that melts in a small bowl and an ice cube that melts in a small ball with a tea light underneath) 2. Reflection on and discussion of the observed results 3. Explanation of the aggregation states of water and the transition processes (i.e., explanation of the role of the temperature and temperature changes of the air; introduction of the concept of water vapor; relation between temperature and air moisture) 4. Presentation of the respective lesson plans for the implementation in class	Hands-on experiments in small groups, trainer input, plenum discussion • Linking of input on CK and PCK with the contents and materials needed for teaching third grade science classrooms • Combination of input, practice, and reflection • Collaboration among participants

	60 min	The hydrologic cycle 1. Experimentation related to the hydrologic cycle (e.g., pouring hot water into a pot and observing what happens to the lid) 2. Reflection on and discussion of the observed results 3. Explanation of the hydrologic cycle (i.e., introduction of the concept of density; explanation of the role of the temperature and temperature changes of the air) 4. Presentation of the respective lesson plans for the implementation in class	Hands-on experiments in small groups, trainer input, plenum discussion • Linking of input on CK and PCK with the contents and materials needed for teaching third grade science classrooms • Combination of input, practice, and reflection • Collaboration among participants
	15 min	Question and answer-session regarding the PD contents	Plenum discussion • Clarification and consolidation of the PD contents

Note. The PD for the elementary school science topic of "evaporation and condensation" was based on a field-tested procedure (cf. Pollmeier et al., 2017).

C. Detailed Description of the PD for Language Support in Science Classrooms

Setting	Time (approx.)	Content	Methods and Didactics
Module 1: Basics of language scaffolding (three face-to-face meetings, 16 hours altogether)			
Training Session 1: Language demands in elementary school science			
Face-to-face meeting after school hours (duration including breaks: 4 hours)	30 min	Welcome reception, overview over the PD for language support in science classrooms, organizational issues	Trainer input
	30 min	Importance and appropriateness of language support in elementary school science and during experimentation (e.g., illustration of the process-oriented terms such as *assume, explain* needed during the scientific process)	Trainer input, brainstorming, plenum discussion • Activation of prior knowledge regarding the importance and appropriateness of language support in elementary school science
	60 min	Language demands during experimentation • Experimentation related to the topic of "floating and sinking", based on the instructions and worksheets that were originally designed for students • Reflection on and discussion of possible linguistic difficulties the instructions and the explanation of experiments might pose to third grade students	Hands-on experiments in small groups, trainer input, plenum discussion • Identification of linguistic challenges in elementary school science • Combination of input, practice, and reflection • Collaboration among participants
	60 min	Language demands in school and in science textbooks • Short introduction into basic linguistic terminology (e.g., morphology, pragmatics) and the register of academic language and its challenges • Identification of academic language features in a text from an elementary school science text book	Trainer input, completion of work assignments • Combination of input and application

	30 min	• Introduction into the analysis of the linguistic demands of teaching materials (macro-scaffolding) • Identification of the linguistic demands of the lesson plan of one out of 6 double lessons on "floating and sinking" (homework)	Trainer input • Application of the newly acquired knowledge (homework) • Consolidation of the PD contents (homework)
Training Session 2: Assessing students' language skills and fostering language skills based on the scaffolding approach			
Face-to-face meeting after school hours (duration including breaks: 4 hours)	30 min	Presentation and discussion of the homework (teachers' analysis of the linguistic demands of the lesson plan of one double lesson on "floating and sinking")	Plenum discussion, feedback • Clarification and consolidation of the PD contents
	15 min	Language development and language skills in elementary school children (e.g., typical vocabulary size in different grade levels; syntactical and morphological knowledge of monolingual students and dual language learners)	Trainer input
	60 min	Formal and informal ways of language assessment • Introduction into the topic of language assessment at the school level: purpose, diagnostic tools (e.g., observation, standardized tests), presentation of informal methods for assessing language skills in class (e.g., observation during classroom discussion and/or group work based on self-developed recording sheets, analysis of written text in work sheets etc.) • Planning of an analysis of students' language skills needed for understanding and fully participating in the 1st double lesson of the curriculum on "floating and sinking" • Classroom observation based on short video clips: Assessment of students' language skills on the topic of "floating and sinking" (2nd double lesson) using record sheets	Trainer input, completion of work assignments, work in pairs • Combination of input, practice, and reflection • Collaboration among participants

		Introduction to the scaffolding approach for fostering language development • Presentation of the basic idea of the scaffolding approach (i.e., providing systematic support for students' language development and stepwise reduction of this support as students' competencies increase) and its central components, namely macro-scaffolding (analysis of the language demands of a topic, assessment of students' language skills related to the respective topic, lesson planning based on language demands and language skills) and micro-scaffolding (language support in class using language-support strategies), which should help students progress from the use of rather colloquial language register to the academic language register • Presentation of important language-support strategies, namely input strategies, questions, feedback strategies, and strategies for focusing students' attention (for detailed descriptions and examples, see Table 1 in the manuscript), and examples • Application of at least four language-support strategies in teachers' regular classroom teaching and self-evaluation of their effects	Trainer input, practical use of language-support strategies in class (homework) • Combination of input, practice (homework), and reflection (homework) • Consolidation and application of the newly acquired knowledge (homework)
Training Session 3: Lesson planning and preparation of the application in class			
Full day face-to-face meeting during and after school hours (duration	30 min	Recap: Overview of the scaffolding approach and important language-support strategies (with examples taken from the curriculum of "floating and sinking")	Teacher input • Clarification and consolidation of the PD contents
	90 min	Application of the language-support strategies	Completion of work assignments, group work, plenum discussion

including breaks: 8 hours)		• Presentation and discussion of the homework (i.e., reflection of teachers' experiences when using selected language-support strategies in their regular classroom teaching) • Group work aimed at deepening teachers' comprehension and application of selected language-support strategies (e.g., formulating language-supportive questions for exemplary situations within the experimentation process, developing appropriate feedback strategies as reactions to specific student utterances)	• Combination of input, practice (homework), and reflection (homework) • Consolidation and application of the newly acquired knowledge • Collaboration among participants
	60 min	Application of the macro-scaffolding and micro-scaffolding components of the scaffolding approach to the "floating and sinking" curriculum • Presentation of a framework for the targeted promotion of selected language terms and concepts (terms like "assume" that play an important role throughout the whole curriculum and technical terms such as "displace" or "density" that refer to central concepts of the topic need to be used and consolidated across multiple lessons; technical terms such as "stainless steel ball", however, are only introduced and used in single lessons) and suggestions for language support (e.g., use of word cards for introducing terms, asking open-ended questions and providing multiple opportunities for language use for consolidating previously learned terms)	Trainer input, plenum discussion
	60 min	Integrating science teaching and language support (I) • Recap: Overview of the teaching manual for the six double lessons on "floating and sinking"	trainer input • Repetition and consolidation of contents from the PD on "floating and sinking"
	90 min	Integrating science teaching and language support (II) • Group work aimed at a) developing concrete strategies for including language-supportive elements into the lesson plans	Group work, role play, plenum discussion, trainer input

		on “floating and sinking” and b) implementing the developed language-supportive elements in a role play • Presentation of the updated version of the teaching manual for “floating and sinking” (including didactical and methodological comments on language support)	• Combination of input, practice, and reflection • Collaboration among participants
Module 2: Coaching and video feedback (based on at least two lessons of the curriculum on “floating and sinking” taught in class)			
Session 1: Classroom observation by the trainer and subsequent one-on-one feedback			
Regular classroom teaching and one-on-one meeting (face-to-face) at school and during school hours	90 min (45 min teaching; 45 min feedback and reflection)	Contents of the one-on-one feedback: 1. Teacher’s own reflection of the attainment of the language-supportive goals they had set for themselves 2. Trainer’s feedback highlighting successful language support and giving suggestions for further development 3. Joint formulation of new language-support goals for the next lesson (e.g., a teacher whose students formulated a lot of assumptions set the goal of prompting them to formulate more justifications for their assumptions and reflected on suitable language-supportive questions)	Classroom teaching, one-on-one feedback, coaching • Consolidation and application of the PD contents • Combination of input (from previous PD sessions), practice, and reflection
Session 2: Videotaping of classroom teaching and subsequent video-feedback coaching in small groups			
Face-to-face meetings with 4 to 6 teachers and a trainer after school hours (one meeting per teacher)	2-3 hours per meeting	Contents and structure of the video-feedback sessions: 1. Presentation of a short video clip (1-3 min) of the classroom teaching of one of the participating teachers and accompanying questions that should guide the observation and subsequent peer feedback (e.g., Which expression is fostered in the video clip and how? Which ideas do you have for further language support in this situation?) 2. Participants’ feedback based on the *reflecting team-method* (i.e., the teacher who is displayed in the video clip listens to the other participants’ feedback (auditor); the other group	Video-feedback, reflecting team-method, group work, coaching • Consolidation and application of the PD contents • Combination of input (from previous PD sessions), practice, and reflection • Modeling • Collaboration among participants

		members comment on the questions in an appreciative way and without directly addressing the auditor) 3. Summary and supplementary coaching ideas by the trainer 4. Repetition of this structure for each video clip (8-10 video clips per session)	
Session 3: Reflection meeting with all IG-participants			
Face-to-face meeting during school hours (duration including short breaks: 3 hours)	60 min	Reflection and discussion of the language-supportive aspects of application phase of the PD based on a number of guiding questions (e.g., Which of the suggestions from the one-on-one feedback and/or the video-feedback have you already implemented in your classroom teaching and what were your experiences?)	Small group work, plenum discussion • Consolidation of PD contents • Combination of practice and reflection • Collaboration among participants
	45 min	Wrap-up of the experiences on language-supportive teaching during the application phase of the PD • Short recap of contents of the theoretical phase of the PD (e.g., the application of a range of language-support strategies and their stepwise reduction students master the respective language demands) • Illustration by selected best-practice video clips from the previous video-feedback sessions in small groups	Trainer input, video-feedback, plenum discussion • Consolidation of PD contents • Combination of input, practice, and reflection • modeling
	45 min	Reflection and discussion of the content-related aspects of the application phase of the PD • Collecting teachers' feedback on the feasibility of the curriculum and their suggestions for improvement which were used for revising the curriculum prior to the implementation phase of the project	Plenum discussion • consolidation of the contents of the PD on "floating and sinking" • Linking of PCK for "floating and sinking" with language-supportive teaching

D. Items from the Language-Support Skills Scale (LASSKI)[1]

1. You and your teacher colleagues regularly conduct classroom observations at your school. Today, you visit a colleague in her Grade 2 classroom and join the morning circle. Your colleague is particularly interested in learning to provide her students with targeted language-support.

Please read the following transcript from the conversation in class.

Teacher: Do you want to tell something else?
Ramona: Yes.
Teacher: Go on.
Ramona: Then we were to my cousin. And then my aunt come. Then we have, uhm, we partied.
Teacher: Yes.
Ramona: Well. *(Murmuring in the background)*
Teacher: And then you partied with your aunties? That's so nice. (*Students talk loudly in the back, chairs are being shifted around, chatter)*. Please listen to what Ramona has to tell. *(Ramona shakes her head).* You don't want to? Okay. So everyone please get yourself a chair and we'll sit down here in this circle.
Students walk through the classroom to get themselves a chair and they sit down in a circle.

If you see chances for delivering this lesson sequence in a more language-supportive way, which would that be?

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[1] Presentation of only those items that were included in the analyses (authors' own translation).

2. The students are about to conduct an experiment in class. Before they start, the teacher asks the students to express their assumptions on what will happen during the experiment.

Teacher: So far, we can only make assumptions on what will happen. As soon as we've conducted the experiment, we have a proof whether our assumption was right or wrong. So far, we can only collect ideas on what could happen – so we can only assume what might happen. What do you assume?

A student raises her hand.

Teacher: Yes, ... what do you assume?

a) What kind of language support does the teacher apply in the above example?

- Explicit language support ☐
- Focus on form ☐
- Implicit language support ☐
- Dialogic language support ☐

b) Please indicate what the teacher fosters in this situation?

In this situation, the teacher fosters:

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3. „Scaffolding“ is a teaching concept in which, based on an interactive process, the teacher helps the students master a task or attain a developmental step the students would not have been able to accomplish on their own. Implementing this concept in language-supportive science classes requires the planning of various aspects. Which of the following form part of this planning phase?

		yes	no
a)	Analysis of the linguistic demands of the lesson contents	☐	☐
b)	Identification of students who are in need for additional language support	☐	☐
c)	Analysis of students‘ language skills in regard of the lesson contents	☐	☐
d)	Lesson planning, initiating the development of the academic language register	☐	☐
e)	Analysis of competences, assessing students’ content-related skills	☐	☐

4. In line with the scaffolding approach, in order to help students formulate utterances in conceptually written language, it makes sense to…

		yes	no
a)	…translate technical terms in students’ first languages.	☐	☐
b)	…to refrain from using pictures and figures, since this reduces the linguistic input.	☐	☐
c)	…to provide exemplary linguistic structures (e.g., if-then-phrases).	☐	☐

References

Decker, A.-T., Hardy, I., Hertel, S., Lühken, A., & Kunter, M. (2020). Die Entwicklung von fachdidaktischem Wissen und Überzeugungen von Grundschullehrkräften im Kontext von Lehrerfortbildungen zum „Schwimmen und Sinken“ [The development of primary school teachers’ pedagogical content knowledge of the topic “floating and sinking” and beliefs about science teaching and learning in a professional development workshop]. *Psychologie in Erziehung und Unterricht, 67*(1), 61-76. https://doi.org/10.2378/peu2020.art06d

Pollmeier, J., Tröbst, S., Hardy, I., Möller, K., Kleickmann, T., Jurecka, A., & Schwippert, K. (2017). Science-P I: Modeling conceptual understanding in primary school. In D. Leutner, J. Fleischer, J. Grünkorn, & E. Klieme (Eds.), *Competence assessment in education: research, models and instruments* (pp. 9-17). Springer International Publishing. https://doi.org/10.1007/978-3-319-50030-0_2